Neural Dynamics approaches to Cognitive Robotics

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Exercise: Instabilities in Dynamic Fields

The neural field dynamics of Amari are based on this equation:

$$\tau_u \dot{u}(x,t) = -u(x,t) + h_u + S(x,t) + \int dx' \; w(x-x') \; \sigma(u(x'))$$

The sigmoidal function is given by

$$\sigma(u) = \frac{1}{1+\exp[-\beta_u \; u]}.$$

The interaction kernel is given by

$$w(x-x') = -c_{\text{inh}} + c_{\text{exc}} \; \exp\left[-\frac{(x-x')^2}{2\sigma_{\text{exc}}^2}\right].$$

Input localized around locations, x_i, of strength, S_i, and widths, σ_i is supplied in the form

$$S(x,t) = \sum_i S_i \exp\left[-\frac{(x-x_i)^2}{2\sigma_i^2}\right].$$

Use the interactive simulator `interactiveSim1l.m` to reproduce the instabilities we discussed in the lecture.

1. Detection instability and reverse detection: increase localized input strength, S_i and then decrease it again.

2. Selection: Provide two localized inputs and vary their relative strength. Observe stabilization of a selection decisions.

3. Boost induced detection: Supply small subthreshold input and increase resting level.

4. Selection of categorical response: Provide two localized inputs of identical strength below threshold. Increase resting level. Vary noise to see how either category is selected.

5. Memory instability: vary resting level and probe if self-stabilized peaks are sustained.